REMARKS/ARGUMENTS

Favorable reconsideration of this application, as presently amended and in light of the following discussion, is respectfully requested.

Claims 27-45 and 53-64 are pending in the present application, Claims 27-45, and 53-64 having been amended, and Claims 1-26 and 46-52 having been canceled without prejudice or disclaimer. Support for the amendments to the claims is believed to be self-evident from the originally filed disclosure.[1] Applicants respectfully submit that no new matter is added.

In the outstanding Office Action, Claims 1, 2, 8-10, 12, 15, 16, 27, 28, 34-36, 38, 41, and 42 were rejected under 35 U.S.C. §102(b) as anticipated by Kub et al. (U.S. Patent No. 6,274,892, hereinafter Kub); Claims 3, 29, 11, and 37 were rejected under 35 U.S.C. §103(a) as unpatentable over Kub; Claims 4, 30, 53, 54, and 56 were rejected under 35 U.S.C. §103(a) as unpatentable over Kub in view of Pike, Jr. et al. (U.S. Patent No. 5,528,058, hereinafter Pike); Claims 55-57 were rejected under 35 U.S.C. §103(a) as unpatentable over Kub in view of Pike, and further in view of Kish, Jr. et al. (U.S. Patent No. 5,783,477, hereinafter Kish) and Abe et al. (U.S. Patent Publication No. 2002/0157790, hereinafter Abe); Claims 5-7 and 31-33 were rejected under 35 U.S.C. §103(a) as unpatentable over Kub in view of Kish and Abe; Claims 13, 14, 39, and 40 were rejected under 35 U.S.C. §103(a) as unpatentable over Kub in view Yu et al. (U.S. Patent No. 6,410,371, hereinafter Yu); and Claims 17, 19, 43, and 45 were rejected under 35 U.S.C. §103(a) as unpatentable over Kub in view of Abe.

Applicants thank the Examiners for the courtesy of an interview extended to Applicants' representative on March 31, 2009. During the interview, differences between the present invention and the applied art, and the rejections noted in the outstanding Office

[1] For example, see page 3, lines 11-14, page 13, lines 6-12 and 26, page 12, lines 12-14, page 14, lines 18-20, page 15, lines 3-4, and page 17, lines 24-25 of the originally filed specification, and Figs. 1C, 4C, 5E, and 6B.

Action were discussed. No agreement was reached pending the Examiner's further review when a response is filed. Arguments presented during the interview are reiterated below.

Initially, it is noted that the Abstract is replaced with one that better conforms with U.S. patent practice.

With respect to the rejection of Claim 27 as anticipated by Kub, Applicants respectfully submit that the amendment to Claim 27 overcomes this ground of rejection. Amended Claim 27 recites, *inter alia*,

> after the molecular bonding, forming a metallic ohmic contact including alloys formed between the implanted metallic species and the semiconducting materials of the first wafer and the second wafer, said metallic ohmic contact being formed at an assembly interface between the first wafer and the second wafer,
>
> wherein the forming includes causing the implanted metallic species to diffuse towards the interface between the first wafer with the second wafer and beyond the interface.

Kub does not disclose or suggest every element of amended Claim 1.

Applicants' Figs. 1A-1C show a non-limiting example of the invention defined by Claim 27. Metallic species 4 are implanted in a first wafer 2. Then, the first wafer 2 and a second wafer 12 are assembled by molecular bonding. Then, at the assembly interface 16, an ohmic contact is formed by the metallic species and the semiconducting material of the wafers after the implanted species have diffused from where they were implanted toward the assembly interface and beyond the interface.

Kub describes implanting a metallic species to form lifetime killing regions.[2] The implanted species are designated on Figs. 5 and 6 of Kub by reference numerals 92 and 102. The lifetime killing regions are confined to certain areas.[3] Moreover, "[t]he region of the

[2] Kub, col. 7, lines 4-5, and col. 16, lines 62-65.
[3] Kub, col. 16, lines 60-62.

power device that has lifetime killing in it typically has higher forward voltage since many of the injected carriers recombine in the lifetime killing region ***rather than transit from anode to cathode***."[4] Thus, the lifetime killing implants have to be maintained in the bulk of the substrate.

Furthermore, the process described in col. 8, line 57 to col. 9, line 37 indicates that zones 92 and 102 are formed by implantation, but that interface 103 between both substrates is free from implanted species diffusing toward the interface 103 and beyond.[5] Here, again, the implanted species remain in the bulk of the substrate.

Col.5, lines 28-30 of Kub states "[t]he gettering region will diffuse lifetime killing transition metals from the bulk of the wafer to the gettering site **PRIOR** to thinning and direct bonding" (emphasis added). Col.3, lines 5-8 of Kub states "[t]he lifetime killing regions are preferably vertically spaced from the bonded interface by a predetermined distance, such as about 10μm." In other words, the life time killing regions (LKR) are formed **BEFORE** bonding. Diffusion results in the LKR being located 10μm from the interface, which means that after diffusion the implanted atoms are located at 10 μm (an example with 0.5 μm is discussed below).

The method defined by Claim 27 is different since formation of metallic compounds is performed formed ***after*** molecular bonding (see Claim 27). The formation of the metallic compounds modifies the molecular bonding (see page 3, lines 10-14 of the present specification, and see also page 10, lines 26-30 of the present specification, which states in part "this compound reinforces the assembly of the two substrates"). This means that diffusion occurs **AFTER** molecular bonding.

Page 3 of the Office Action refers to col.7, lines 53-60 of Kub, which concerns a low anneal temperature of 800°C. The statement on page 3 of the Office Action regarding PtSi is

[4] Kub, col. 16, lines 62-65.
[5] Kub, col. 9, lines 35-36.

not supported by the cited portions of Kub (or any other portion). Kub does not explicitly disclose the forming of PtSi, does not indicate that the Pt material diffuses toward the interface and beyond the interface.

At a low anneal temperature of 800°C, no metallic compounds can be formed at the interface in Kub. In support of this position, Applicants submit Bracht, Hartmut, *Diffusion Mechanisms and Intrinsic Point-Defect Properties in Silicon*, MRS Bulletin, June 2000, pp. 22-27 (hereinafter the Bracht document).[6]

Fig. 2 of the Bracht document indicates a diffusion coefficient of less than 10^{-8} for Pt at 800° C. Carbon and oxygen, discussed at col. 7, line 3 of Kub, have much lower diffusion coefficients at 800°C. Fig. 3 of the Bracht document indicates (for Ge in Si) that even for a depth of 0.25 μm (which is even lower than the 0.5 μm of Kub at col.18, line.10), the concentration at depth 0 (surface) is negligible.

Considering Fig. 3 of the Bracht document, a person of ordinary skill in the art understands that diffusion does not allow significant concentrations far from the initial implantation zone. In Fig. 3 of the Bracht document, a comparison is made before and after heating at 1050°C. The concentration profile is of course modified due to diffusion at 1050°C, but diffusion cannot bring a significant concentration of atoms to the surface, and cannot bring a significant concentration of atoms beyond the interface.

If the Office should continue to disagree with this position, the Office must provide substantial evidence to support its position. Accordingly, the Examiner is called upon, under 37 CFR §1.104(d)(2), to supply his affidavit, including his credential to testify as one of ordinary skill in the art, setting forth that the disclosure of Kub would be interpreted by a person of ordinary skill in the art as teaching the claimed:

[6] An IDS submitting this reference is also filed herewith.

> after the molecular bonding, forming a metallic ohmic contact including alloys formed between the implanted metallic species and the semiconducting materials of the first wafer and the second wafer, said metallic ohmic contact being formed at an assembly interface between the first wafer and the second wafer,
>
> wherein the forming includes causing the implanted metallic species to diffuse towards the interface between the first wafer with the second wafer and beyond the interface.

In this regard, it is noted that substitution of an improper subjective conclusion as to knowledge in the art for concrete evidence of such knowledge relative to a core factual finding required for a determination of patentability is clearly improper. See In re Zurko, 59 USPQ2d 1693, 1697-98 (Fed. Cir. 2001) as follows:

> Finally, the deficiencies of the cited references cannot be remedied by the [PTO's] general conclusions about what is "basic knowledge" or "common sense" to one of ordinary skill in the art. As described above, the [PTO] contended that even if the cited UNIX and FILER2 references did not disclose a trusted path, "it is basic knowledge that communication in trusted environments is performed over trusted paths" and, moreover, verifying the trusted command in UNIX over a trusted path is "nothing more than good common sense." *Ex parte Zurko*, slip op. at 8. We cannot accept these findings by the [PTO]. This assessment of basic knowledge and common sense was not based on any evidence in the record and, therefore, lacks substantial evidence support. As an administrative tribunal, the [PTO] clearly has expertise in the subject matter over which it exercises jurisdiction. This expertise may provide sufficient support for conclusions as to peripheral issues. With respect to core factual findings in a determination of patentability, however, the [PTO] cannot simply reach conclusions based on its own understanding or experience — or on its assessment of what would be basic knowledge or common sense. Rather, the [PTO] must point to some concrete evidence in the record in support of these findings. [Emphasis added.]

The even more recent Lee decision by the Federal Circuit Court of Appeals (In re Lee, 61 USPQ2d, 1430, 1435 (2002)) is again noted to emphasize the need for the PTO to provide actual evidence on the record, not mere unsupported opinion, as follows:

> In finding the relevant facts, in assessing the significance of the prior art, and in making the ultimate determination of the issue of obviousness, the examiner and the Board are presumed to act from this viewpoint [that of the person of ordinary skill in the art to which the subject matter pertains]. Thus when they rely on what they assert to be general knowledge to negate patentability, that knowledge must be articulated and placed on the record. [Emphasis added.]

The Lee court further specifically found it to be erroneous and arbitrary conduct for the PTO to attempt to resolve questions material to patentability by reliance upon "subjective belief and unknown authority" (see In re Lee at 61 USPQ2d 1434) as is being done here. Also note the Kotzab court admonition (at 55 USPQ2d 1317) that "[b]road conclusory statements are not evidence."

Concentrations of the implanted species are also an issue that needs to be considered when evaluating Kub. The concentrations of the implanted species in Kub are insufficient to form an ohmic contact. A person of ordinary skill in the art would expect a concentration of about 10^{21} cm^{-3} to form an ohmic contact. Kub always cites much lower concentrations, such as:

- Col.12, lines 17– 22 : "The N+ buffer layer may be fabricated by implanting a thin, about 200 nm thick, layer with a concentration of about 1×10^{19} cm-3 of N-type dopant, such as arsenic, antimony or phosphorous into the surface of the P+ substrate. The P+ substrate may have a concentration of about 3×10^{18} to 1×10^{19} cm-3 of P-type dopant."
- Col.14, lines 9-10: "into a P+ substrate that has a concentration of approximately 3×10^{18} cm-3."

- Col.17, lines 65-67: "One technique is to implant He ions with sufficient energy so that they are buried beneath the surface about 0.5 MU m and at sufficient doses (1 x 10^{16} cm-3)...."
- Col.18, lines 32-42: "a)oxygen implant to create oxygen precipitates that are buried beneath the silicon surface that will act as recombination centers. The anneal to create oxygen precipitates typically involves a long time anneal at 650°C. to nucleate the precipitates, an anneal at 950 °C. to grow the precipitates, and then possibly an anneal at 1100 °C. to grow stacking faults. The ion implantation dose typically required to create a high density of oxygen is typically less than about 1 x 10^{15} cm-3 and will not roughen the surface as much as is the case for the He implant that causes the bubbles.

  b). Carbon implants to create carbon precipitates beneath the surface.

  c). Ge implants to create lateral regions of misfit dislocations that are buried beneath the surface upon which the epitaxial layer is grown."

In other words, even considering an implantation depth of 0.5 μm,[7] and the concentrations noted above, Kub cannot obtain an ohmic contact at the interface. The distance of 0.5 μm is too large to allow diffusion of the implanted species from the implanted zone to the interface and beyond the interface.

Furthermore Claim 27 does not only recite the diffusion of the metallic species, but also the formation of a metallic ohmic contact.

Even if the Office were to maintain its position that there is some diffusion of the implanted species in Kub to and beyond the interface, Claim 27 requires that the diffusion be sufficient to form an ohmic contact.

[7] Kub, col. 18, lines 9-11.

Thus, Kub does not disclose or suggest the claimed

> after the molecular bonding, forming a metallic ohmic contact including alloys formed between the implanted metallic species and the semiconducting materials of the first wafer and the second wafer, said metallic ohmic contact being formed at an assembly interface between the first wafer and the second wafer,
>
> wherein the forming includes causing the implanted metallic species to diffuse towards the interface between the first wafer with the second wafer and beyond the interface.

In view of the above-noted distinctions, Applicants respectfully submit that Claim 27 (and any claims dependent thereon) patentably distinguish over Kub.

With respect to the rejection of Claim 53 as unpatentable over Kub and Pike, Claim 53 recites elements analogous to those of Claim 27. Thus, Claim 53 (and any claims dependent thereon) patentably distinguish over Kub. Moreover, Pike does not cure the deficiencies in Kub.

Moreover, Kish, Yu, and Abe have been considered but do not cure the above-noted deficiencies in Kub.

Furthermore, Applicants respectfully submit that Claim 29 further patentably distinguishes over Kub. Claim 29 recites "implanting the metallic species at a depth of between 5 nm and 20 nm under a surface of the first wafer." Pages 6-7 of Office Action indicates that this feature is obvious because "discovering the optimum or workable range involves only routine skill in the art." Applicants respectfully traverse this position.

The claimed the depth of implantation is critical to the formation of the ohmic contact. As discussed above, if the depth is too great, then the ohmic contact cannot be formed. Moreover, the range of 5 nm to 20 nm is a difference in kind, and not one of degree, when compared to the 10 μm and 0.5 μm examples from Kub. These large differences, when compared to Kub, show the criticality of the claimed values. In *In re Waymouth*, 499 F.2d

1273, 1276, 182 USPQ 290, 293 (CCPA 1974), the court held that unexpected results for a claimed range as compared with the range disclosed in the prior art had been shown by a demonstration of "a marked improvement, over the results achieved under other ratios, as to be classified as a difference in kind, rather than one of degree." Here, a marked improvement is achieved because no ohmic contact is formed in Kub.

Furthermore, the specification also states "[s]ince the implanted zone is sufficiently close to the surface, formation of this (these) conducting compound(s) will then be induced and molecular bonding will be modified by the presence of this (these) conducting compound(s)."[8] Thus, the implantation depth is critical in modification of the molecular bonding.

Thus, the claimed "implanting the metallic species at a depth of between 5 nm and 20 nm under a surface of the first wafer" is not mere optimization.

Furthermore, it is not obvious to modify Kub to change the implantation depth. The purpose of Kub is to form the lifetime killing regions in the bulk of the substrate. Changing the implantation depth so that the lifetime killing regions do not remain in the bulk of the substrate would change the principle of operation of Kub and render Kub unsatisfactory for its intended Purpose. According to MPEP §§ 2143.01(V) and (VI), "[i]f proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification ," and "[i]f the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious."

[8] Specification, page 3, lines 12-15.

Consequently, in light of the above discussion and in view of the present amendment, the present application is believed to be in condition for allowance and an early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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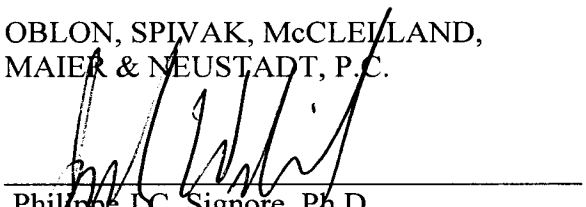

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